

# **Updated Status of Federally Listed ESUs of West Coast Salmon and Steelhead**

**West Coast Salmon Biological Review Team**

**Northwest Fisheries Science Center**

2725 Montlake Boulevard East  
Seattle, WA 98112

**Southwest Fisheries Science Center**

Santa Cruz Laboratory  
110 Shaffer Road  
Santa Cruz, CA 95060

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This is a scientific report. It does not represent or set policy for NMFS or NOAA, regardless of whether any statements contained herein may appear to do so.

## **C.2.2 SOUTHERN OREGON/NORTHERN CALIFORNIA COASTS COHO SALMON**

**Primary contributors: Brian C. Spence, Thomas C. Wainwright, and Eric P. Bjorkstedt  
(Southwest Fisheries Science Center – Santa Cruz Lab and  
Northwest Fisheries Science Center)**

### **C.2.2.1 Summary of Previous BRT Conclusions**

The Southern Oregon/Northern California Coast (SONCC) coho salmon Evolutionarily Significant Unit (ESU) extends from Cape Blanco in southern Oregon to Punta Gorda in northern California (Weitkamp et al. 1995). The status of coho salmon coastwide, including the SONCC ESU, was formally assessed in 1995 (Weitkamp et al. 1995). Two subsequent status review updates have been published by NMFS, one addressing all West Coast coho salmon ESUs (NMFS 1996b) and a second specifically addressing the Oregon Coast and Southern Oregon-Northern California ESUs (NMFS 1997). Information from those reviews regarding extinction risk, risk factors, and hatchery influences is summarized in the following sections.

#### **Status indicators and major risk factors**

**California populations**—Data on population abundance and trends were limited for the California portion of the SONCC ESU. The BRT found no regular estimates of natural spawner escapement for coho salmon in the SONCC, and most information used by the BRT came from reviews by California Department of Fish and Game (CDFG 1994) and Brown et al. (1994). Historical point estimates of coho salmon abundance for the early 1960s and mid 1980s cited in these reviews were taken from CDFG (1965), Wahle and Pearson (1987), and Sheehan (1991)<sup>2</sup>. These estimates suggest that statewide coho spawning escapement in the 1940s ranged between 200,000 and 500,000 fish (E. Gerstung, CDFG pers. comm. cited in Brown et al. 1994). By the early-to-mid 1960s, statewide escapement was estimated to have declined to just under 100,000 fish (CDFG 1965), with approximately 43,000 fish (44%) originating from rivers within the SONCC ESU (Table C.2.2.1). Wahle and Pearson (1987) estimated that statewide coho salmon escapement had declined to approximately 30,000 fish by the mid-1980s, with about 12,400 (41%) originating within the SONCC ESU. For the late 1980s, Brown et al. (1994) estimated wild and naturalized coho salmon populations at 13,240 for the state, and 7,080 (53%) for the California portion of the SONCC ESU. To derive their estimate, they employed a “20-fish rule” in which all streams known to historically support coho salmon, except those for which recent surveys indicated coho salmon no longer persist (19% of the total), were assumed to still support 20 spawners. For streams where a recent estimate of spawner abundance existed, they used either that estimate or 20 fish, whichever was larger. They suggested that application of the “20-fish rule” likely overestimated total abundance. As Brown et al. (1994) point out, all of these historical estimates are “guesses” of fishery managers and biologists generated using a combination of limited catch statistics, hatchery records, and personal observations.

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<sup>2</sup>For mid-1980s estimates, Brown et al. (1994) cite Wahle and Pearson (1987) who estimate 30,480 total spawners in California whereas CDFG (1994) cites Sheehan’s (1991) estimate of 33,500 spawners. It is unclear how Sheehan’s estimates were derived and no basin-specific estimates are presented; thus, we have included the estimates of Wahle and Pearson (1987) in Table C.2.2.1 rather than the Sheehan (1991) estimates cited by the BRT (Weitkamp 1995).

Table C.2.2.1. Historical estimates of coho salmon spawner abundance for various rivers and regions within the Southern Oregon/Northern California Evolutionarily Significant Unit.

River/Region	Estimated Escapement		
	CDFG (1965) <sup>a</sup>	Wahle & Pearson (1987) <sup>b</sup>	Brown et al. (1994) <sup>c</sup>
	1965	1984-1985	1987-1991
CA rivers trib. to OR coast streams	1,000		
Smith River	5,000	2,000	820 <sup>d</sup>
Other Del Norte County	400		180 <sup>d</sup>
Klamath River	15,400	3,400	1,860
Mainstem Klamath River & tribs.	8,000	1,000	
Shasta River	800	300	
Scott River	800	300	
Salmon River	800	300	
Trinity River	5,000	1,500	
Redwood Creek	2,000	500	280
Mad River	2,000	500	460
Eel River	14,000	4,400	2,040 <sup>d</sup>
Mainstem Eel River	500	200	
Van Duzen River	500	200	
South Fork Eel River	13,000	4,000	
North Fork Eel River	0	0	
Middle Fork Eel River	0	0	
Mattole River	2,000	500	760 <sup>d</sup>
Other Humboldt County	1,500	1,130	680 <sup>d</sup>
ESU Total	43,300	12,430	7,080
California Statewide Total <sup>e</sup>	99,400	30,480	13,240

<sup>a</sup>. Excludes ocean catch.

<sup>b</sup>. Estimates are for wild or naturalized fish; hatchery returns excluded.

<sup>c</sup>. Estimates are for wild or naturalized fish; hatchery returns excluded. For streams without recent spawner estimates (or estimates lower than 20 fish), assumes 20 spawners.

<sup>d</sup>. Indicates high probability that natural production is by wild fish rather than naturalized hatchery stocks.

<sup>e</sup>. Estimated number of coho salmon for CCC ESU and California portion of the SONCC ESU combined.

Additional information regarding the status of coho salmon in the SONCC ESU was obtained from an analysis of recent (1987-1991) occurrence of coho salmon in streams historically known to support coho populations (Brown et al. 1994). Of 115 historical streams in the SONCC ESU for which recent data were available, 73 (63%) were determined to still support coho salmon, whereas it was believed they had been lost from 42 (37%). The estimated percentage of streams with coho salmon still present was lower for Del Norte County (55%) than for Humboldt County (69%). NMFS (1996b) presented more recent data (1995-1996) on presence of coho salmon within the SONCC ESU, which suggested that the percentage of streams still supporting coho salmon was lower than estimated by Brown et al. (1994). Of 176 streams recently surveyed in the SONCC ESU, 92 (52%) were found to still support coho salmon (P. Adams, NMFS Southwest Fisheries Science Center, pers. comm. cited in NMFS 1996b). The estimated percentage of streams still supporting coho salmon was lower (46%) in Del Norte County than in Humboldt County (55%).

Two recent reviews assessing the status of coho salmon stocks in California were also reviewed by the BRT. Nehlsen et al. (1991) identified coastal populations of coho salmon north of San Francisco Bay (includes portions of the SONCC and CCC ESUs) as being at moderate risk of extinction and Klamath River coho salmon as a stock of special concern. The Humboldt Chapter of the American Fisheries Society (Higgins et al. 1992), utilizing more detailed information on individual river basins, considered three stocks of coho salmon in the SONCC ESU as at high risk of extinction (Scott River [Klamath], Mad River, and Mattole River), and eight more stocks as of special concern (Wilson Creek, Lower Klamath River, Trinity River, Redwood Creek, Little River, Humboldt Bay tributaries, Eel River, and Bear River)<sup>3</sup>.

**Oregon populations**—For the 1997 status update (NMFS 1997), the BRT was asked to evaluate the status of the ESU under two conditions: first, under existing conditions; second, assuming that hatchery and harvest reforms of the Oregon Coastal Salmon Restoration Initiative (OCSRI) were implemented.

**Evaluation under existing conditions**—In the Rogue River Basin, natural spawner abundance in 1996 was slightly above levels in 1994 and 1995. Abundances in the most recent 3 years were all substantially higher than abundances in 1989-1993, and were comparable to counts at Gold Ray Dam (upper Rogue) in the 1940s. Estimated return ratios for 1996 were the highest on record, but this may have been influenced by an underestimate of parental spawners. The Rogue River run included an estimated 60% hatchery fish in 1996, comparable to previous years. The majority of these hatchery fish returned to Cole Rivers Hatchery, but there was no estimate of the number that strayed into natural habitat.

**Evaluation with hatchery and harvest reforms**—The BRT considered only two sets of measures from the OCSRI—harvest management reforms and hatchery management reforms. The BRT did not consider the likelihood that these measures will be implemented; rather, it only considered the implications for ESU status if these measures were fully implemented as described. The BRT had several concerns regarding both the harvest and hatchery components of the OCSRI plan. Some members had a strong concern that we do not know enough about the

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<sup>3</sup> Weitkamp et al. (1995), citing Higgins et al. (1992), indicate that the numbers of stocks at “moderate risk of extinction” and “of special concern” in the SONCC are 6 and 10, respectively. These numbers appear to be in error.

causes of declines in run size and recruits per spawner to be able to directly assess the effectiveness of specific management measures. Some felt that the harvest measures were the most encouraging part of the plan, representing a major change from previous management. However, there was concern that the harvest plan might be seriously weakened when it is re-evaluated in the year 2000 and concern about our ability to effectively monitor non-target harvest mortality and to control overall harvest impacts.

Of the proposed hatchery measures, substantial reductions in smolt releases were thought to have the most predictable benefit for natural populations; all else being equal, fewer fish released should result in fewer genetic and ecological interactions with natural fish. Marking all hatchery fish should also help to resolve present uncertainties about the magnitude of these interactions. However, the BRT expressed concerns regarding some aspects of the proposed hatchery measures. The plan was vague on several key areas, including plans for incorporation of wild broodstock and how production would be distributed among facilities after 1997. One concern was that the recent and proposed reductions appear to be largely motivated by economic constraints and the present inability to harvest fish if they were produced rather than by recognition of negative effects of stray hatchery fish on wild populations. Other concerns expressed by the BRT included no reductions in fry releases in many basins and no consideration of alternative culture methods that could be used to produce higher-quality hatchery smolts, which may have less impact on wild fish. Another concern was the plan's lack of recognition that hatchery-wild interactions reduce genetic diversity among populations.

Specific risk factors identified by the BRT included low current abundance, severe decline from historical run size, the apparent frequency of local extinctions, long-term trends that are clearly downward, degraded freshwater habitat and associated reduction in carrying capacity, and widespread hatchery production using exotic stocks. Of particular concern to the BRT was evidence that several of the largest river basins in the SONCC—including the Rogue, Klamath, and Trinity rivers—were heavily influenced by hatchery releases of coho salmon. Historical transfer of stocks back and forth between SONCC and CCC streams was common, and SONCC streams have also received plants from stocks from hatcheries in the lower Columbia River/Southwest Washington, Puget Sound/Strait of Georgia, and Oregon Coast ESUs. However, the BRT considered the frequency of out-of-basin plants to be relatively low compared with other coho salmon ESUs. Recent (late 1980s and early 1990s) droughts and unfavorable ocean conditions were identified as further likely causes of decreased abundance.

### **Previous BRT conclusions**

In the 1995 status review, the BRT was unanimous in concluding that coho salmon in the SONCC ESU were not in danger of extinction but were likely to become so in the foreseeable future if present trends continued (Weitkamp et al. 1995). In the 1997 status update, estimates of natural population abundance in this ESU were based on very limited information. Favorable indicators included recent increases in abundance in the Rogue River and the presence of natural populations in both large and small basins, factors that may provide some buffer against extinction of the ESU. However, large hatchery programs in the two major basins (Rogue and Klamath/Trinity) raised serious concerns about effects on, and sustainability of, natural populations. New data on presence/absence in northern California streams that historically

supported coho salmon were even more disturbing than earlier results, indicating that a smaller percentage of streams in this ESU contained coho salmon compared to the percentage presence in an earlier study. However, it was unclear whether these new data represented actual trends in local extinctions, or were biased by sampling effort. This new information did not change the BRT's conclusion regarding the status of the SONCC ESU. Although the OCSRI proposals were directed specifically at the Oregon portion of this ESU, the harvest proposal would affect ocean harvest of fish in the California portion as well. The proposed hatchery reforms can be expected to have a positive effect on the status of populations in the Rogue River Basin. However, the BRT concluded that these measures would not be sufficient to alter the previous conclusion that the ESU is likely to become endangered in the foreseeable future.

### **Listing status**

Coho salmon in the SONCC ESU were listed as threatened in May of 1997 (62FR24588). On July 18, 1997, NMFS published an interim rule (62FR38479) that identified several exceptions to the Endangered Species Act's Section 9 take prohibitions.

## **C.2.2.2 New Data and Updated Analyses**

Because data types and sources differ substantially between the California and Oregon portions of the ESU, we present information separately for each area.

### **California populations**

Since the status review for West Coast coho salmon (Weitkamp et al. 1995) and subsequent updates (NMFS 1996b, and NMFS 1997) were completed, new data and analyses related to the status of coho salmon in the California portion of the SONCC ESU have become available. Most data are of two types: 1) compilations of presence-absence information for coho streams from the period 1987 to the present, and 2) new data on densities of juvenile coho salmon in index reaches surveyed by private timber companies. We found no time series of adult counts (excepting those substantially influenced by hatchery production), and only five time series of adult spawner indices (maximum live/dead counts) for tributaries of the Eel River (Sprowl Creek), the Mad River (Canon Creek), and the Smith River (West Branch of Mill Creek [two datasets] and East Branch of Mill Creek) that span a period of 8 years or more, none of which are considered reliable indicators of population trends. Limitations of these datasets are discussed in detail below.

Two independent analyses of presence-absence and limited time series data for the SONCC have been published recently. CDFG (2002) analyzed coho salmon presence-absence for SONCC streams spanning broodyears 1986-2000. NMFS (2001b) published an updated status review for coho salmon in the California portion of the SONCC, which also included analysis of presence-absence information. Since then, scientists at the Southwest Fisheries Science Center have continued compiling data on coho salmon distribution and abundance and re-analyzed the updated data, inclusive of data used in the CDFG (2002) analysis. Thus, results presented in this report supercede those presented in NMFS (2001b).

## CDFG presence-absence analysis

**Methods**—Staff at the North Coast Region of the California Department of Fish and Game attempted to gather all published and unpublished data collected for 392 streams identified by Brown and Moyle (1991) as historical coho salmon streams<sup>4</sup>. Sources of data included field notes, planting records, and fish surveys from federal, state and tribal agencies, private landowners, and academic institutions, as well as summaries contained in several recently published status reviews (Ellis 1997, Brownell et al. 1999, and NMFS 2001b). For each stream and year in which surveys were conducted, observations of coho salmon presence or absence were assigned to the appropriate broodyear. If more than one life stage was observed during a survey, then presence was assigned to more than one broodyear. Streams that were not surveyed during a particular year were assigned a “presence” value if fish were documented in an upstream tributary during that year. Overall, the CDFG dataset encompasses records from broodyear 1986 to 2000, or five complete brood cycles. Additionally, CDFG (2002) presented results of an extensive field study conducted in the summer of 2001 in which 287 of the 392 Brown and Moyle (1991) streams were surveyed for juvenile coho salmon presence-absence<sup>5</sup>.

For their brood-year analysis, CDFG (2002) compared the percentage of streams for which coho salmon were detected at any time during two time periods: broodyears 1986-1991 and 1996-2000. The first period was designed to coincide with the period encompassed by the Brown and Moyle (1991) study. Statistics were generated based on data from all streams within the SONCC on the original Brown and Moyle list as well as the subset of these streams that were sampled at least once during each of the two time periods. CDFG (2002) also calculated the percentage of streams for which coho salmon were detected in the 2001 field survey.

**Results**—Including only streams on the Brown and Moyle list, CDFG (2002) found that coho salmon were observed in 143 of 235 (61%) streams surveyed during the period covering broodyears 1986-1991 (Table C.2.2.2). This number is similar to the value of 63% found by Brown and Moyle (1991) based on information on about half as many streams (115). For broodyears 1995-2000, surveys were conducted on 355 of the 392 historical coho salmon streams. Of these, coho salmon were detected in 179 (50%), suggesting a decline in occupancy. However, when the analysis was restricted to only the 223 streams for which data were available from both time periods, the percent of streams in which coho were detected went from 62% in 1986-1991 to 57% in 1995-2000, a change that was not statistically significant (Pearson Chi square test,  $p = 0.228$ ; Yates corrected chi square test,  $p = 0.334$ ).

For the 2001 field survey, presence was confirmed in only 121 (42%) of the 287 streams surveyed within the SONCC ESU. CDFG (2002) makes two cautions in interpreting their year 2001 results. First, CDFG considered sampling intensity to be sufficient to have a high likelihood of detecting fish for only 110 of the 166 streams where coho salmon were not found. Second, they note that absence of fish in a single year class does not mean that fish have been extirpated from the system.

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<sup>4</sup>Brown and Moyle (1991) identified 396 streams in California as historical coho streams; however, four of those streams were dropped by CDFG either because barriers make historically occupancy highly unlikely, because the record of occurrence likely reflects a hatchery outplanting, or because streams were duplicated in the Brown and Moyle list.

<sup>5</sup>CDFG repeated their survey of Brown and Moyle (1991) streams in the summer of 2002; however, those data were unavailable at the time of their analysis.

Table C.2.2.2. Historical presence of coho salmon in the SONCC ESU, as determined by Brown and Moyle (1991) and the California Department of Fish and Game's presence-by-broodyear investigation (as of February 2002). County classifications are based on the location of the mouth of the river system. Table modified from CDFG (2002).

County/River Basin	Brown and Moyle (1991) Calendar years 1987-1990				CDFG (2002) Broodyears 1986-1991				CDFG (2002) Broodyears 1995-2000			
	# of streams		# of streams		# of streams		# of streams		# of streams		# of streams	
	w/info.	coho present	%		w/info.	coho present	(%)		w/info.	coho present	%	
<b>Del Norte County</b>												
Coastal	9	1	1		8	5	3		8	8	6	
Smith River	41	2	2		41	21	7		41	39	14	
Klamath River	113	41	21		112	82	48		112	89	55	
Subtotal	163	44	24	54%	161	108	58	53%	161	136	75	55%
<b>Humboldt County</b>												
Coastal	34	7	7		33	16	14		33	32	18	
Redwood Creek	14	3	3		14	12	12		14	14	11	
Mad River	23	2	2		23	10	8		23	22	14	
Eel River	124	56	34		123	80	48		123	116	45	
Mattole River	38	3	3		38	9	3		38	35	16	
Subtotal	233	71	49	69%	231	127	85	67%	231	219	104	47%
ESU Total	396	115	73	63%	392	235	143	61%	392	355	179	50%



## NMFS presence-absence analysis

**Methods**—Scientists at the NMFS Southwest Fisheries Science Center compiled a presence-absence database for the SONCC similar to that developed by CDFG. The dataset includes information for coho salmon streams listed on the Brown and Moyle (1991) list, as well as other streams for which we have found historical or recent evidence of coho salmon presence. The dataset is a composite of information contained in the NMFS (2001b) status review update, additional information gathered by NMFS since the 2001 status review was published, data used in the CDFG (2002) analysis, and additional data compiled by CDFG (Bill Jong, CDFG, North Coast Region, unpublished data) for streams not on the Brown and Moyle (1991) list. As such, the database combines information taken from primary sources such as stream surveys, data reports, and electronic files, as well as from secondary sources, including recent compilations of presence-absence data by Ellis (1997), Brownell et al. (1999), NMFS (2001b), CDFG (2002); and Bill Jong, CDFG (unpublished data). In many cases, we were unable to obtain original sources underlying the various data compilations and so have generally relied on the accuracy of these secondary sources.

There are four significant differences between the data and analytical approach used by NMFS as compared with CDFG's (2002) status review. First, the NMFS analyzed data for all streams with some historical record of coho salmon presence, whereas CDFG restricted their analysis to those streams found on the Brown and Moyle (1991) list. Second, the NMFS database spans a slightly different time period: broodyears 1987 to 2001 (rather than 1986 to 2000). At the time these data were compiled, data from summer 2002 field surveys were only partially reported; thus, results from broodyear 2001 are preliminary. Third, unlike CDFG (2002), we did not infer presence in streams on the basis of occurrence in upstream tributaries. Although there is an intuitive logic to assigning presence to streams en route to a particular location, including these "inferred presence" values in the analysis tends to positively bias the overall estimate of percent occupancy because the same rationale for inference cannot be applied in the case of a recorded "absence." The magnitude of this bias on estimated occupancy rates for a given year depends on several factors including the proportion of streams sampled, the true occupancy rate for the year, and basin size, all of which effect how many inferences of presence can be made. And finally, in our analysis, we present summary information both by broodyear and by brood cycle (3-year aggregation). In contrast, in their broodyear analysis, CDFG (2002) calculated percent occupancy for 6-year time spans (two complete brood cycles); any observation of presence during that 6-year window resulted in a value of presence for the entire period.

Concerns have been expressed (CDFG 2003) about the validity of including certain streams cited as historical coho streams in various previously published status reviews. We have removed streams from our list that we have found to be in error, including those explicitly identified by CDFG as questionable. However, we have retained information provided by secondary sources in the absence of contradictory information. We have also compared our historical stream list with that developed by CDFG and have found that, although the NMFS stream list includes some streams not found on CDFG's list, most of these streams have limited if any data associated them. We estimate that observations associated with these streams constitute only about 1% of the more than 9,000 observations in the database, and the proportion of "presence" values in this subset is comparable to those observed for the entire dataset. Thus, even if

some of these streams are found to be in error, their inclusion likely has minimal effect on estimated occupancy rates for the ESU.

Results for the NMFS presence-absence analyses are presented by major watersheds or aggregations of adjacent watersheds (Table C.2.2.3). In general, results from larger watersheds are presented independently, whereas data from smaller coastal streams, where data were relatively sparse, are grouped together. In a few cases, individual smaller coastal streams with only a few observations were aggregated with adjacent larger streams if there was no logical geographic grouping of smaller streams. We did not perform statistical analyses of temporal trends in estimated occupancy rates because of the substantial variation in the sampling methods and intensities represented in the dataset, both at the level of individual observations (e.g., index reaches versus whole stream surveys) and among years (i.e., changes in the number of streams surveyed or the principle survey methods through time). Fitting a statistical model to these data without better understanding of the underlying error structure would be of questionable value and would give an illusion of analytical rigor that is likely not supported by the underlying data.

**Results**—On an annual basis, the estimated percentage of streams in the SONCC for which coho salmon presence was detected has generally fluctuated between 36% and 61% between broodyears 1986 and 2000 (Figure C.2.2.1). Data that have been reported for the 2001 broodyear suggest a strong year class, as indicated by an occupancy rate of more than 75%; however, the number of streams for which data have been reported is small compared to previous years. The data suggest that, for the period of record, occupancy rates in the SONCC were highest (54-61%) between broodyears 1991 and 1997, and then declined between 1998 and 2000 (39-51%) before rebounding in 2001. The pattern is similar whether all historical coho streams or just those identified in Brown and Moyle (1991) are considered (Figure C.2.2.1).

When data were aggregated over complete brood cycles (3-year periods), the percentage of streams for which coho salmon presence was detected remained relatively constant (between 60% and 67%) between the 1987-1989 and 1996-1998 brood cycles (Table C.2.2.3). Percent occupancy for the 1999-2001 brood cycle was lower at 46%; however, interpretation of this apparent decline is complicated by two factors. First, the number of streams surveyed was higher than in any other period due to CDFG's intensive survey of the Brown and Moyle streams in the summer of 2001, a drought year. Second, reporting from the 2002 summer season (broodyear 2001) remains incomplete, and as noted above, preliminary data indicate that the 2001 broodyear was strong. Thus, it is likely that the percent occupancy for this period will increase after all data from CDFG's 2002 survey and other sources are analyzed. When analysis was restricted to streams on the Brown and Moyle (1991) list, the ESU-wide pattern was almost identical, with percent occupancy values being within 1%-2% for all time periods (data not shown). Overall, it appears that, although there is considerable year-to-year variation in estimated occupancy rates, there has been no dramatic change in the percent of coho salmon streams occupied from the late 1980s and early 1990s to the present.

Table C.2.2.3. Percent of surveyed streams within the SONCC ESU for which coho salmon were detected for four time intervals: broodyears 1987-1989, 1990-1992, 1993-1995, 1996-1998, and 1999-2001. Streams include those for which historical or recent evidence of coho salmon presence exists. Based on NMFS and CDFG data (excluding inferred presences in CDFG data).

County and River Basins	Number of Streams with Historical Presence	1987-1989			1990-1992			1993-1995			1996-1998			1999-2001		
		Number Surveyed <sup>1</sup>	Coho Present <sup>2</sup>	Coho Absent <sup>3</sup>	Number Surveyed <sup>1</sup>	Coho Present <sup>2</sup>	Coho Absent <sup>3</sup>	Number Surveyed <sup>1</sup>	Coho Present <sup>2</sup>	Coho Absent <sup>3</sup>	Number Surveyed <sup>1</sup>	Coho Present <sup>2</sup>	Coho Absent <sup>3</sup>	Number Surveyed <sup>1</sup>	Coho Present <sup>2</sup>	Coho Absent <sup>3</sup>
<b>Del Norte (includes OR tributaries)</b>																
Illinois River	9	0	-	-	2	100%	0%	2	50%	50%	7	100%	0%	4	75%	25%
Smith River-Winchuck River	57	20	20%	80%	19	42%	58%	45	53%	47%	28	32%	68%	44	43%	57%
Klamath River -Trinity River	210	128	66%	34%	127	72%	28%	139	68%	32%	135	62%	38%	133	55%	45%
<b>Humboldt</b>																
Redwood Creek	23	10	80%	20%	10	100%	0%	19	79%	21%	13	92%	08%	19	84%	16%
Stone/Big Lagoons	5	1	0%	100%	2	100%	0%	1	0	100%	2	50%	50%	5	20%	80%
Little River - Strawberry Creek	9	8	100%	0%	9	100%	0%	6	100%	0%	5	100%	0%	6	83%	17%
Mad River	23	8	100%	0%	7	86%	14%	7	86%	14%	9	78%	22%	22	64%	36%
Humboldt Bay tributaries	48	20	95%	5%	16	94%	6%	32	97%	3%	17	88%	12%	24	63%	37%
Eel River	221	109	47%	53%	126	59%	41%	132	58%	42%	59	31%	69%	151	30%	70%
Bear River-Guthrie Creek	5	0	-	-	0	-	-	3	0%	100%	2	0%	100%	4	0%	100%
Mattole River-McNutt Gulch	56	5	60%	40%	11	36%	64%	21	71%	29%	42	79%	21%	41	37%	63%
ESU Total	666	309	60%	40%	329	67%	33%	407	66%	34%	319	60%	40%	453	45%	55%
<sup>1</sup> Total number of streams surveyed at least once within the three-year interval																
<sup>2</sup> Percentage of surveyed streams where coho were present in one or more years during the interval																
<sup>3</sup> Percentage of surveyed streams where coho were absent in all years of survey during the interval																

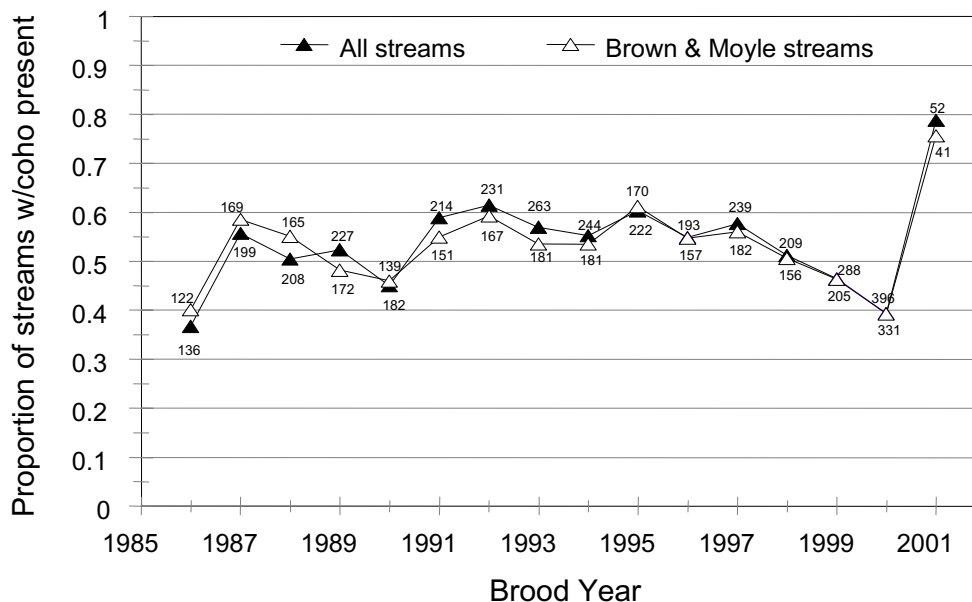


Figure C.2.2.1. Percent of streams surveyed for which coho salmon presence was detected, by broodyear, for all historical coho streams (solid triangles) and coho streams identified in Brown and Moyle's (1991) historical list (open triangles) within the SONCC ESU. Sample sizes (i.e. number of streams surveyed) are shown next to data points. Data are from combined NMFS and CDFG datasets (excluding inferred presence values in the CDFG data).

In general, the proportion of streams sampled within any individual watershed (or grouping of watersheds) was sufficiently small or variable among time periods to make interpretation of local trends difficult. The most notable exception was the Eel River, which showed occupancy rates declining from between 48% and 58% in the period between 1987 and 1995 to about 30% in the past two brood cycles. Similarly, the percentage of streams with coho salmon presence in the Klamath-Trinity system appears to have declined over the five brood cycles examined, though the magnitude of the decline is smaller: from between 66% and 71% in 1987 to 1995 to 62% and 55% in the past two brood cycles. In both cases, reporting from the 2001 broodyear is incomplete, and anecdotal reports suggest that inclusion of more data from the 2002 sampling year (2001 broodyear) may increase the observed percentages because of the relatively strong adult returns in the winter of 2001-2002. Thus, these apparent declines should be interpreted with caution. Still, the relatively low percentage of streams that still support coho salmon in the Eel River and the possible downward trend in the Klamath River basin, despite continued heavy hatchery influence, are cause for concern given that these are the largest river basins in the California portion of the SONCC and, if historical estimates are accurate (Table C.2.2.1), once accounted for well over half of the coho salmon produced in the California portion of the SONCC ESU.

The results of NMFS analysis are generally consistent with those of CDFG (2002), both suggesting a general decline in occupancy rates in from the late 1980s and early 1990s to the end of the 1990s, the significance of which remains somewhat uncertain because of non-systematic collection of presence-absence information and variation in sampling intensity (i.e., the number streams surveyed) through the period. NMFS (2001b) suggested that declines in

percent occupancy in the SONCC from 1989 to 2000 were significant; however, the addition of new data makes us more cautious in this interpretation. Though the trend remains apparent, the magnitude of change is less than the previous data indicated. A more exhaustive examination of stream surveys from the SONCC region compiled by CDFG has substantially increased the total number of observations in the dataset (especially in the earliest years) and those additional observations have been strongly weighted toward “absences.” Regardless, there is no evidence suggesting that occupancy rates have increased since the original status review for SONCC coho salmon was published in 1995.

### **Adult time series**

Reliable current time series of naturally produced adult migrants or spawners are not available for SONCC ESU rivers. Spawner surveys have been conducted annually by the California Department of Fish and Game on 4.5 miles of Sprowl Creek, tributary to the Eel River, since 1974 (except in 1976-1977) and on 2 miles of Cannon Creek, tributary to the Mad River, since 1981 (PFMC 2002b). However, these surveys are conducted primarily to generate minimum chinook counts and the likelihood of detecting coho salmon is influenced strongly by the frequency of sampling and environmental conditions (i.e., turbidity) during those surveys (CDFG 2003). Spawner surveys have been conducted by Jim Waldvogel (UC Cooperative Extension, unpublished data) on the West Branch Mill Creek, a tributary to the Smith River, from 1980 to 2001. Peak live/dead counts have fluctuated between 2 and 28 fish during this period, again making their use for trend analysis inappropriate. Surveys have also been conducted on the West Branch (4.7 miles) and East Branch (5.4 miles) of Mill Creek by Stimson Timber Company since 1993. Maximum live/dead counts recorded by Stimson on the West Branch averaged 62 fish between 1993 and 1996, declining to an average of 4 fish between 1997 and 2000. On East Branch, maximum live/dead counts averaged 32 fish between 1993 and 1996, declining to an average of 6 fish between 1997 and 2000 (Howard 1998; Paul Albro, Stimson Lumber Company, unpublished data). Howard (1998) notes that the reliability of these counts varies with flow conditions.

### **Juvenile time series**

**Methods**—Juvenile density estimates have been made during summer at seven index sites within the Eel River basin over the past 8 to 18 years: Upper Indian Creek, Moody Creek, Piercy Creek, Dutch Charlie Creek, and Redwood Creek in the South Fork Eel River basin (Steven Levesque and David Wright, Campbell Timberland Management, unpublished data); and two sites on Hollow Tree Creek in the Middle Fork Eel Basin (Scott Harris, CDFG, unpublished data). We performed an analysis of juvenile density to determine whether such patterns observed in juveniles are consistent with those observed in the analysis of presence-absence information.

To estimate a trend, data were log-transformed and then normalized so that each data point was expressed as a deviation from the mean of that specific time series. The normalization was intended to prevent spurious trends that could arise from different methods of data collection. Following transformation, time series were aggregated, based on watershed structure, into groups thought to plausibly represent independent populations. Linear regression was used to estimate trends (i.e., slopes) for each aggregate dataset. Analysis was restricted to 1) sites

where a minimum of 8 years of data were available, and 2) putative populations where more than 65% of the observations were non-zero values.

**Results**—Aggregate trends were estimated separately for the South Fork Eel River and Middle Fork Eel River sites. In both cases, trends were positive, but not significantly different from 0 (South Fork: slope 0.053, 95% CI from -0.074 to 0.180; Middle Fork: slope 0.016, 95% CI from -0.051 to 0.180).

## **Oregon populations**

One effect of the OCSRI has been increased monitoring of salmon and habitats throughout the Oregon coastal region. Besides continuation of the abundance data series analyzed in the 1997 status update, Oregon has expanded its random survey monitoring to include areas south of Cape Blanco, including monitoring of spawner abundance, juvenile densities, and habitat condition.

**Spawner abundance**—In the Oregon portion of the ESU, spawner abundance is monitored only in the Rogue River Basin. Other small coastal basins have limited coho salmon habitat, and are not thought to have sustainable local coho salmon populations (Jacobs et al. 2002). Within the Rogue Basin, two methods are used to monitor adult abundance: beach-seine surveys conducted at Huntley Park in the upper estuary, and stratified-random spawning ground surveys (Jacobs et al. 2002). The Huntley Park seine estimates provide the best overall assessment of both naturally produced and hatchery coho salmon spawner abundance in the basin (Figure C.2.2.3). Spawner survey-based abundance estimates are also available for the basin since 1998, when the surveys were expanded south of Cape Blanco. These estimates are consistently lower than the seine-based estimates, which may be due in part to losses during upstream migration (Jacobs et al. 2002); however, ODFW considers the seine-based estimates to be more accurate as an overall assessment of spawner abundance (S. Jacobs, ODFW, pers. comm. October 2002). The spawning-ground surveys allow examination of the distribution of spawners among subbasins: in 2001, the majority of spawners were in main tributaries (Illinois and Applegate Rivers and Evans and Little Butte Creeks).

The occurrence of hatchery fish in natural spawning areas is also a consideration for the productivity of the natural population. Roughly half of the total spawning run in the Rogue River Basin is hatchery fish; however, many of these fish return to Cole Rivers Hatchery, rather than spawning in natural habitat. Based on fin-mark observations during spawning-ground surveys, the average percent of natural spawners that are of hatchery origin has ranged from less than 2% (2000) to nearly 20% (1998) in recent years. These hatchery spawners are largely concentrated in the mainstem tributaries, with very few hatchery fish observed in major tributaries (Jacobs et al. 2002).

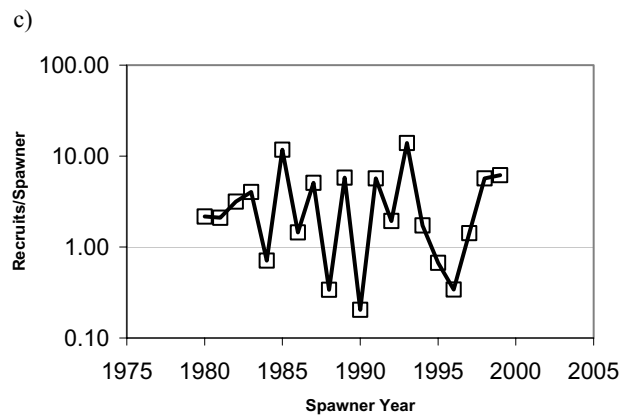
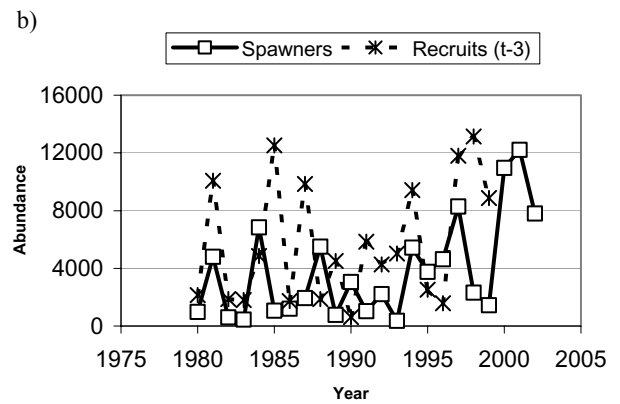
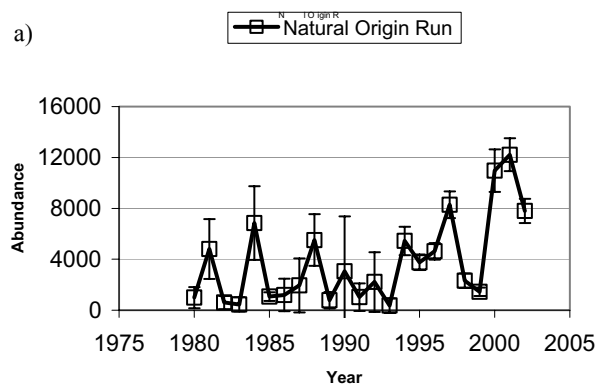


Figure C.2.2.3. Trends in Rogue River coho salmon populations, based on ODFW surveys at Huntley Park (Jacobs et al. 2002). a) Natural spawner abundance with 95% confidence interval; b) Pre-harvest recruits and spawner abundance; c) Recruits (lagged 3 years) per spawner (note logarithmic scale).

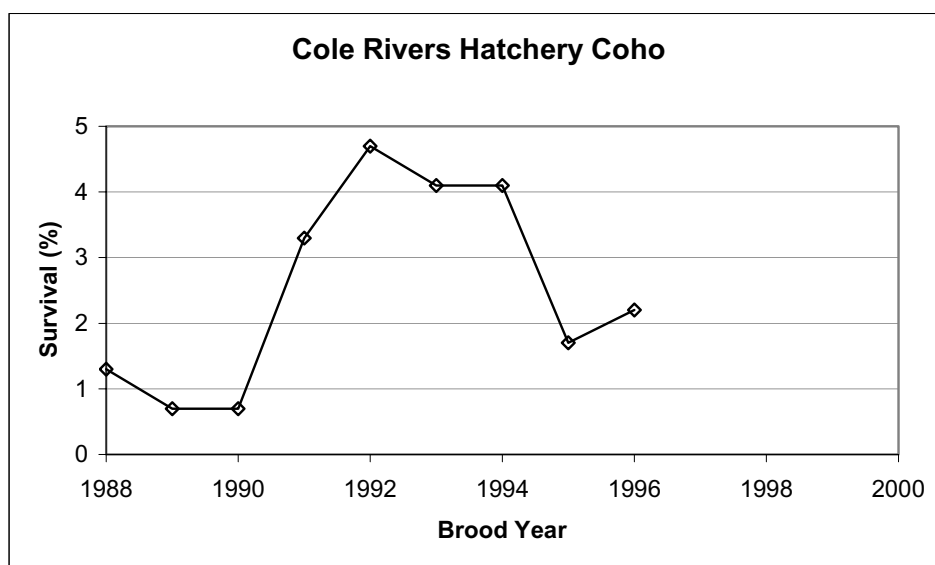


Figure C.2.2.4. Percent survival of CWT-marked coho salmon from Cole Rivers Hatchery, calculated from data in Lewis (2002).

**Results**—Mean spawner abundance and trends for Rogue River coho salmon are given in Table C.2.2.4. (Note that because estimates of hatchery-origin fish on the spawning ground are not available for most years, lambda was not computed for this population.) Both short- and long-term trends in naturally produced spawners are upward; however, this increasing trend in spawners results largely from reduced harvest, as trends in pre-harvest recruits are smaller (Figure C.2.2.3, Table C.2.2.4). Recruits per spawner fluctuate widely, with little apparent trend (Figure C.2.2.3). Fluctuations in naturally produced spawner abundance are generally in phase with survival of hatchery fish (Figure C.2.2.4), suggesting that ocean conditions play a large role in population dynamics. Note that hatchery-fish survival for the Rogue River stock is generally higher and follows a different pattern than the general OPI survival index (see Oregon Coast ESU discussion).

**Juvenile density**—Regular monitoring of juvenile coho salmon in the Oregon portion of the SONCC ESU began in 1998, and 4 years of data are currently available, as reported in Rodgers (2002). Several statistics are reported, including percent occupancy and mean density. Methods differ from the California surveys reported above, so direct comparison of results is problematic. The most comparable statistic to the California presence/absence data is “percentage of sites with at least one pool containing coho,” which has been steadily increasing from about 30% in 1998 to 58% in 2001; this compares with a range of 52% to 80% for other parts of the Oregon coast. Percentage of pools per site containing coho salmon has also increased, reaching 41% (s.e. 4.9%) in 2001. Mean juvenile density has also increased over the 3 years. In 2001, overall mean density of juveniles in surveyed pools was 0.38 fish per square meter ( $\text{fish} \cdot \text{m}^{-2}$ ); this compares with a range of 0.27 to 0.50  $\text{fish} \cdot \text{m}^{-2}$  for other areas of the Oregon coast.



Table C.2.2.4 Abundance and trend estimates for Rogue River Basin coho salmon natural spawners, estimated from Huntley Park seine data (Jacobs et al. 2002) from 1980 to 2001. Shown are the most recent geometric mean (along with minimum and maximum values for the data series) and trend estimates for spawners and recruits, both long- and short-term, along with the probability that the true trend is decreasing.

Parameter	Value	95% C.I.	P(decrease)
<b>Recent spawner abundance</b>			
Last 3 years geometric mean	10147		
Last 3 years arithmetic mean	10326		
Last 3 years range	7800-12213		
<b>Spawner Trend</b>			
Short-term (1990-2002)	1.16	(1.01, 1.34)	0.02
Long-term (1980-2002)	1.08	(1.01, 1.15)	0.01
<b>Pre-Harvest Recruit Trend</b>			
Short-term (1990-2002)	1.08	(.94, 1.25)	0.12
Long-term (1980-2001)	1.02	(0.95, 1.08)	0.27

**Habitat condition**—The Oregon Plan Habitat Survey (OPHS) began in 1998, as part of the ODFW Aquatic Inventories Project begun in 1990. Information here is derived from the Survey's year 2000 report (Flitcroft et al. 2001). The survey selects 500-m to 1,000-m sites along streams according to a spatially balanced random selection pattern. The survey includes both summer and winter habitat sampling. In addition to characterization of the site's streamside and upland processes, specific attributes sampled are: large wood, pools, riparian structure, and substrate. The program has established benchmark thresholds as indicators of habitat quality:

- Pool area greater than 35% of total habitat area;
- Fine sediments in riffle units less than 12% of all sediments;
- Volume of large woody debris greater than 20 m<sup>3</sup> per 100 m stream length;
- Shade greater than 70%;
- Large riparian conifers more than 150 trees per 305 m stream length.

For the combined 1998-2000 surveys in the Oregon portion of the SONCC ESU, 6% of sites surveyed met none of the benchmarks, 29% met one, 38% met two, 20% met three, 5% met four, and 2% met all five benchmarks. No trends in habitat condition can yet be assessed from this data, but it will provide a basis for future assessment of changes in habitat quality.

### C.2.2.3 New Comments

The Siskiyou County Farm Bureau (2002) submitted comments arguing that SONCC coho salmon should not be protected under ESA, particularly because the relationship of Iron Gate Hatchery fish in the Klamath River to the SONCC ESU remains uncertain. Their principal arguments is that widespread historical outplanting of juvenile coho salmon and incorporation of

non-native fish into hatchery broodstock make application of the ESU concept inappropriate; they argue that all West Coast coho salmon should be considered a single ESU.

The Siskiyou Project submitted comments supporting continued listing of coho salmon in the SONCC under ESA (Siskiyou Project 2002). They argue that 1) the status of native, naturally reproducing coho salmon in the SONCC remains unchanged since they were listed in 1997; 2) increases in adult coho salmon observed in 2001 and 2002 are mostly due to improved ocean conditions and reduced harvest, and are not indicative of long-term trends; 3) severe drought in the winter 2001-2002 and summer 2001 are likely to result in lower smolt production in spring 2002 and adult returns in 2003; 4) habitat already in poor condition is likely to deteriorate with increasing human demands for natural resources and inadequate regulations; and 5) continued large releases of hatchery coho salmon pose a threat to naturally produced fish through competition, mixed-stock fishing, and reduced fitness associated with interbreeding of hatchery and wild fish. The Siskiyou Project also included a report authored by Cindy Deacon Williams, private consultant, titled *Review of the status of Southern Oregon/Northern California coho with thoughts on recovery planning targets*. Ms. Williams' report presents basin-by-basin assessments of the status of coho salmon (using primarily previously published analyses), habitat conditions, and ongoing activities that pose risks to coho salmon. She also recommends numeric recovery criteria for SONCC coho salmon and argues that habitat targets are needed to ensure recovery.

The Douglas County Board of Commissioners submitted a report, *Viability of coho salmon populations on the Oregon and northern California coasts*, submitted to NMFS Protected Resources Division on 12 April 2002 and prepared by S.P. Cramer and Associates, Inc. (Cramer and Ackerman 2002). This report analyzes information available for both the Oregon Coastal Coho Salmon ESU and the SONCC ESU in several areas: trends in abundance and distribution, trends in survival, freshwater habitat condition, potential hatchery-wild interactions, changes in harvest regulation, and extinction risk modeling. Little of the information presented in the report is specific to the SONCC ESU. They cite changes in fishery management, increasing spawning escapements, reduced hatchery releases, habitat restoration, and evidence of successful rearing of fry outmigrants throughout the Oregon Coast, some information for the Rogue River basin, but no new information for California populations.

Daniel O'Hanlon (2002a,b), attorney at law, submitted comments on two occasions on behalf of Save Our Shasta and Scott Valley Towns (S.O.S.S), an organization of citizens concerned about the effects of ESA regulations. The latter submission includes comments submitted to the California Fish and Game Commission regarding the petition to list coho salmon in Northern California under the state Endangered Species Act, which include, by reference, a critique of CDFG's (2002) status review prepared by Dr. Charles Hanson. Though the critique is of the state's analysis of coho status, some the arguments are germane to the federal status review since the underlying data are comparable. The essential arguments from this collection of documents are 1) the limited data presented in the initial status reviews was insufficient to assess, in a scientifically rigorous way, the degree of extinction risk facing coho salmon in the SONCC; 2) there is no evidence of an immediate or near-term risk of extinction based on analysis of either presence-absence data or abundance trend data; presence-absence data have a number of weaknesses, and historical trend data (abundance and harvest) are

unreliable; and 3) existing regulatory structures are adequate to protect coho salmon; new regulations would hinder, rather than help coho recovery.

The Yurok Tribal Fisheries Program (2002) submitted recent data from various sampling efforts in the lower Klamath River and its tributaries. Included were data from downstream migrant traps, adult snorkel surveys, tribal harvest, and harvest catch-per-unit effort. Data on relative contribution of naturally produced and hatchery fish to tribal harvest and to catch at the lower Klamath and lower Trinity downstream migrant trapping sites are discussed in the section on New Hatchery/ESU Information below. Other data were incorporated into NMFS presence-absence analysis discussed above. None of the time series available met the minimum criterion of 8 years, which was decided upon by the BRT as the minimum needed for trend analysis.

#### **C.2.2.4 New Hatchery Information**

Weitkamp et al. (1995) identified four hatcheries that were producing and releasing coho salmon within the SONCC ESU during the mid 1990s: Mad River Hatchery, Trinity River Hatchery, Iron Gate Hatchery, and Cole Rivers Hatchery. Prairie Creek hatchery produced coho salmon for many years, but closed in 1992 (CDFG 2002). Rowdy Creek hatchery is a privately owned hatchery that has produced coho salmon in the past; however, the facility did not produce coho salmon in 1999 and 2000 due to lack of adult spawners (CDFG 2002), and no further production of coho salmon at this facility is planned (Andrew VanScoyk, Rowdy Creek Hatchery, pers. comm.).

**Iron Gate Hatchery**—Iron Gate Hatchery (IGH), located on the Klamath River near Hornbrook, California, approximately 306 km from the ocean, was founded in 1965 and is operated by the California Department of Fish and Game (CDFG). The hatchery was built by Pacific Power and Light Company to mitigate effects of the Iron Gate Project on wild salmonids, including coho salmon, that naturally occurred in the upper Klamath River (CDFG 2002; SHHAG 2003). The IGH coho stock was developed initially from eggs taken from Klaskanine Hatchery in Oregon, via Trinity River Hatchery in 1966. In an effort to increase returns to Iron Gate Hatchery, coho salmon from Cascade River (Columbia River) were released in 1966, 1967, 1969, and 1970 (CDFG 2002; CDFG 2003). Since 1977, only Klamath Basin fish have been released from IGH (CDFG 2003).

Annual releases of coho salmon from IGH have decreased from an average of approximately 147,000 fish from 1987-1991 to about 72,000 fish from 1997-1999 (Table C.2.2.5); this reduction in releases reflects effort on CDFG's part to more closely adhere to the IGH mitigation goal of 75,000 yearlings released per year. Adult returns averaged 1,120 fish between 1991 and 2000, and an average of 161 females have been spawned annually during this period.

The CDFG and NMFS Southwest Region Joint Hatchery Review Committee (2001) noted that no accurate estimates of the relative contribution of naturally produced vs. hatchery fish are available for the Klamath River basin. Beginning in 1995, coho salmon released from IGH have been marked with left maxillary clips; however, return information has been published for only a single year, 2000. These data indicate that 80% of 1,353 fish returning to IGH were

marked hatchery fish, with 98% being Iron Gate releases. A few fish from the Trinity and Cole Rivers (Rogue River, Oregon) hatcheries were also taken. The significance of this high percentage of hatchery fish with respect to total production in the Klamath Basin is uncertain since IGH lies near the upper end of the accessible habitat.

Table C.2.2.5. Average annual releases of coho salmon juveniles (fry and smolts) from selected hatcheries in the SONCC coho salmon ESU during release years 1987-1991, 1992-1996, and 1997-2002. Hatchery classification assigned by Salmon and Steelhead Hatchery Assessment Group (SHHAG 2003) is also shown.

Hatchery	SSHAG Category	Average Annual Releases		
		1987-1991	1992-1996	1997-2002
Cochran Ponds (HFAC)		35,391 <sup>a</sup>	na <sup>b</sup>	0 <sup>b</sup>
Mad River <sup>c</sup>	4	372,863	91,632	82,129 <sup>d</sup>
Prairie Creek		89,009 <sup>e</sup>	0 <sup>f</sup>	0 <sup>f</sup>
Trinity River <sup>g</sup>	2b	496,813	385,369	527,715
Iron Gate (Klamath) <sup>h</sup>	2c	147,272	92,150	71,932 <sup>i</sup>
Rowdy Creek <sup>j</sup>		0	12,534 <sup>k</sup>	10,615 <sup>l</sup>
Cole Rivers (Rogue) <sup>m</sup>	2a	271,492	239,534 <sup>n</sup>	270,344 <sup>o</sup>
Total		1,413,380	821,685	1,007,391

<sup>a</sup> Average from 2 years (1987-1988). Source: Weitkamp et al. 1995.

<sup>b</sup> Coho salmon were produced by the Humboldt Fish Action Council (HFAC) through the 1994 broodyear; release data for 1992 to 1996 are currently unavailable; no fish were released after 1996 (S. Holz, HFAC, pers. comm.)

<sup>c</sup> Sources: Weitkamp et al. 1995; Gallagher 1993-1995; Cartwright 1996-2001

<sup>d</sup> CDFG ceased spawning coho salmon at Mad River Hatchery in 1999; yearling were last released in 2001

<sup>e</sup> Average from 4 years (1987-1988, 1990-1991). Source: Weitkamp et al. 1995.

<sup>f</sup> Prairie Creek hatchery ceased producing coho salmon in 1992.

<sup>g</sup> Sources: Ramsden 1993-2002.

<sup>h</sup> Sources: Hiser 1993-1996; Rushton 1997-2002.

<sup>i</sup> Does not include releases from year 2002 (data not available)

<sup>j</sup> Source: A. Van Scoyk, Rowdy Creek Hatchery, unpublished data.

<sup>k</sup> Average from 2 years (1995-1996); data not available for 1992-1995.

<sup>l</sup> Rowdy Creek hatchery ceased releasing coho in year 2001.

<sup>m</sup> Source: Bill Waknitz, NMFS, pers. comm.

<sup>n</sup> Average from 1991-1995.

<sup>o</sup> Average from 1996-2002; includes juvenile coho salmon released to lakes.

Additional information about the composition of Klamath Basin stocks is available from tribal harvest and downstream migrant trap data collected by the Yurok Tribal Fisheries (2002).

Between 1997 and 2000, tribal harvest of coho salmon ranged from 42 to 135 fish and then increased to 895 in 2001. During this five-year period, hatchery fish constituted between 63% and 86% of the total fish harvested. Iron Gate Hatchery fish generally made up a small (8% or less) fraction of total hatchery fish captured, the exception being in 1997, when they constituted about 37% of the hatchery fish caught. In contrast, Trinity River Hatchery fish accounted for 87% to 95% of hatchery fish harvested in 1998-2001, and 40% of the hatchery fish captured in 1997.

In 1997 and 1998, Yurok Tribal Fisheries operated a downstream migrant trap in the lower Klamath River, below the confluence of the Klamath and Trinity rivers; thus the trap captured fish from both the Iron Gate and Trinity hatcheries. During 2 years of sampling, Trinity hatchery fish dominated the total catch accounting for 73% and 83% of all fish caught in 1997 and 1998, respectively. Iron Gate Hatchery fish accounted for around 5% of the catch in both years. Naturally produced coho salmon made up 22% of the total catch in 1997 and 12% of the catch in 1998. In 1998, a second trap was operated on the lower Trinity River. Only 9% of the smolts captured at this trap were naturally produced. Assuming that this proportion accurately reflected the relative contributions of naturally produced and hatchery Trinity River fish to catch at the Lower Klamath trap, then the percentages of naturally produced and hatchery fish exiting the Klamath River proper (above the Trinity confluence) were approximately 42% and 58%, respectively.

In previous status reviews, the BRT was uncertain about whether the use of non-native stocks to start the Iron Gate population was of sufficient importance to have lasting effects on the present population. Thus, they reached no conclusion about whether the hatchery stock should be included in the ESU (NMFS 1997). Subsequently, Iron Gate was determined to be a Category 2 hatchery (SSHAG 2003). For other SSHAG hatchery stock categorizations, see Appendix C.5.1.

**Trinity River Hatchery**—Trinity River Hatchery (TRH), located below Lewiston Dam approximately 248 km from the ocean, first began releasing coho salmon in 1960. The TRH facility originally used Trinity River fish for broodstock, though coho salmon from Eel River (1965), Cascade River (1966, 1967, and 1969), Alsea River (1970), and Noyo River (1970) have also been reared and released at the hatchery as well as elsewhere in the Trinity Basin.

Trinity River Hatchery produces the largest number of coho salmon of any production facility in California. CDFG's annual production target is 500,000 yearlings. Actual production averaged 496,813 from 1987-1991, decreased to 385,369 from 1992-1996, and then increased again to 527,715 fish from 1997-2002 (Table C.2.2.5). During the period 1991-2001, an average of 3,814 adult coho were trapped and 562 females were spawned at the TRH.

It is commonly assumed that there is little production of wild coho salmon in the Trinity River system, and available data generally support this assumption. Between 1997 and 2002, hatchery fish constituted between 89% and 97% of the fish (adults plus grilse) returning to the Willow Creek weir in the lower Trinity River (Sinnen 2002). Outmigrant trapping conducted on the lower Trinity River indicates that marked TRH fish made up 91%, 97%, and 65% of the catch in years 1998, 1999, and 2000, respectively (Yurok Tribal Fisheries 2002). Additionally, it appears that a significant fraction of the naturally produced fish are likely the progeny of hatchery strays. By subtracting the number of hatchery and naturally produced fish returning to TRH from counts at Willow Creek weir, Sinnen (2002) estimated that hatchery fish made up between 76% and 96% of fish that spawned within the Trinity River system upstream of the weir from 1997 to 2002. A potential source of bias in these estimates is that fact that Willow Creek weir typically washes out prior to the end of the coho adult migration season. There is some suggestion that wild Trinity River coho salmon return later in the season than TRH fish, which

would result in an overestimate of hatchery contribution to spawning in the wild (George Kautsky, Hoopa Valley Tribal Fisheries, pers. comm.); however, there are no data by which to assess whether such bias exists. Additionally, we are aware of no information from which to assess 1) the degree to which TRH fish that pass over the weir are straying into various sub-basins within the Trinity River (Hoopa Valley Tribe 2003), or 2) whether hatchery and wild fish have an equal probability of successfully spawning in the wild.

The BRT concluded that coho salmon from the Trinity River Hatchery should be considered part of the SONCC ESU since out-of-basin and out-of-ESU transfers ceased by 1970 and production since that time has been exclusively from fish within the basin. The lack of natural production within the Trinity Basin, however, remains a significant concern. The Trinity Hatchery is a Category 2 hatchery (SSHAG 2003).

**Mad River Hatchery**—Mad River Hatchery (MRH), located approximately 20 km upriver near the town of Blue Lake, first began producing coho salmon in 1970. The original broodstock (1970) was from the Noyo River, which lies outside of the SONCC ESU, and Noyo fish were released from the hatchery during 12 additional years between 1971 and 1996. Other stocks released from the hatchery include out-of-ESU transfers from the Trask River (1972), Alsea River (1973), Klaskanine River (1973), Green River (1979), and Sandy River (1980), as well as out-of-basin, within-ESU transfers from the Trinity River (1971), Klamath River (1981, 1983, 1986-1989), and Prairie Creek (1988, 1990).

Releases of Mad River fish declined substantially during the past decade, from an average of 372,8643 fish in 1987-1991 to just over 82,000 in the period from 1997-2001 (Table C.2.2.5). Production of coho salmon at MRH ceased after broodyear 1999, thus, the year 2001 releases represent the final year of hatchery production. Adult returns were low during the 1990s, with an average of 38 adults trapped and 16 females spawned during the period between 1991 and 1999. No information was available regarding the relative contribution of naturally produced and artificially propagated fish within the Mad River basin. However, concern about both out-of-ESU and out-of-basin stock transfers, as late as 1996, was sufficiently great that the Mad River Hatchery was excluded from the SONCC ESU by NMFS (1997). This conclusion has been rendered moot by the decision to cease producing coho salmon at the Mad River facility.

**Rowdy Creek Hatchery**—Rowdy Creek Hatchery is a privately owned hatchery in the Smith River Basin constructed in 1977. Production emphasis has been on chinook and steelhead, but small numbers of coho salmon were trapped and bred during the period 1990 to 1998. Only local coho salmon broodstock have been used at the Rowdy Creek facility (NMFS 1997).

Annual releases of coho salmon yearlings averaged 12,534 between 1995 and 1996, and 15,923 from 1997 to 2000, when releases were terminated (Table C.2.2.5). Adult returns to the hatchery averaged just 26 fish in the 11 years that coho salmon were trapped (A. Van Scoyk, Rowdy Creek Hatchery, unpublished data). No information was available on the relative contribution of Rowdy Creek Hatchery coho salmon to the Smith River population as a whole, but it was undoubtedly a minor component during the period of operation.

In its status review update, the BRT (NMFS 1997) concluded that the Rowdy Creek Hatchery population should be considered part of the ESU, but that it was not essential for ESU recovery. This conclusion has been rendered moot by the decision to cease producing coho salmon at the facility.

**Cole Rivers Hatchery**—The Cole Rivers Hatchery has raised Rogue River (Oregon stock #52) coho salmon since 1973 to mitigate for lost production due to construction of Lost Creek Dam. This stock was developed from local salmon trapped in the river, and has no history of out-of-basin fish being incorporated. Recent releases (1996-2002) have averaged 270,000 per year, compared to a 1991-1995 average of 240,000 per year (Table C.2.2.5); the increase is due to inclusion in the data of large-sized coho salmon released to lakes in the basin in recent years (Bill Waknitz, NMFS, pers. comm.). Spawning of hatchery fish in nature is essentially limited to mainstem tributaries and (to a lesser extent) the Applegate River, and interbreeding with natural fish is limited by separation in spawning time (Jacobs et al. 2002). The hatchery is rated as a Category 1 hatchery (SSHAG 2003).

## **Summary**

Artificial propagation of coho salmon within the SONCC has been substantially reduced in the past 8 to 10 years, with the exception of Cole Rivers Hatchery on the Rogue River and the Trinity River Hatchery. Annual releases from the Cole Rivers and Trinity hatcheries have recently averaged 270,000 and 528,000 fish, respectively. Production has ceased at one major facility (Mad River), as well as several minor facilities (Rowdy Creek, Eel River, and Mattole River). Production at Iron Gate Hatchery on the Klamath River has been reduced by approximately 50%. Genetic risks associated with out-of-basin and out-of-ESU stock transfers have largely been eliminated. However, two significant genetic concerns remain: 1) the potential for domestication selection in hatchery populations such as Trinity River, where there is little or no infusion of wild genes, and 2) out-of-basin straying by large numbers of hatchery coho.

## **Harvest impacts**

Historically, ocean harvest of SONCC coho salmon has occurred in coho- and chinook-directed commercial and recreational fisheries off the coasts of California and Oregon. Significant changes in harvest management have occurred since the late 1980s, which have resulted in substantial reductions in ocean harvest of SONCC coho salmon. In establishing fishing seasons and regulations each year, the Pacific Fishery Management Council (PFMC) considers the potential impacts on various ESA-listed stocks within the region. Because there are no data on exploitation rates on wild SONCC coho salmon, Rogue and Klamath River (RK) hatchery stocks are used as a fishery surrogate stock for estimating exploitation rates on SONCC coho. The PFMC estimates that most ocean harvest of RK coho salmon (and presumably SONCC coho salmon) occurs south of Humbug Mountain, Oregon, which lies near the northern boundary of the SONCC ESU.

During the 1970s and early 1980s, commercial fishing seasons for coho salmon south of Humbug Mountain generally lasted from four to five months or more (PFMC 2003). These seasons were substantially shortened in the late 1980s and early 1990s, particularly between

Humbug Mountain and Point Arena, California due to changes in allocation fall chinook salmon to tribal and non-tribal fall fisheries in the Klamath Management Zone. Retention of coho salmon in ocean commercial fisheries south of Cape Falcon, Oregon, has been prohibited since 1993 (PFMC 2002b). In 1994, retention of coho salmon in ocean recreational fisheries was prohibited from Cape Falcon south to Horse Mountain, California, and this prohibition was extended to include all California waters in 1995. The retention prohibition has remained in effect south of Humbug Mountain since that time.

Mass-marking (adipose fin clips) of hatchery coho salmon throughout much of the Oregon Production Index area has led to the implementation of mark-selective recreational fisheries for hatchery fish along portions of the coast north of Humbug Mountain beginning in 1998 and continuing through 2002. Marked fish may be legally retained, while unmarked fish must be released unharmed. SONCC-origin coho salmon that migrate north of Cape Blanco experience incidental mortality due to hooking and handling in this fishery; however, total incidental mortality from this fishery and chinook-directed fisheries north of Humbug Mountain has been estimated to be less than 7% of the total mortality of RK hatchery coho salmon since 1999 (PFMC 1999-2003).

In 1999, NMFS issued a biological opinion establishing a consultation standard requiring that overall annual ocean exploitation rate not exceed 13% on RK stocks. To conform to this standard, the Pacific Fishery Management Council (PFMC) adopted fishing seasons in 1999-2002 for which the projected coastwide marine exploitation rate on RK stocks ranged between 3.0 and 7.7%. During that time, an estimated 93% to 97% of this mortality has occurred in chinook-directed fisheries south of Humbug Mountain (PFMC 1999-2003).

Estimates of ocean exploitation rates on SONCC coho salmon for years prior to their listing under ESA are not available. Harvest estimates for various landing ports in California are available dating back to the early 1950s and indicate that annual harvest in the commercial fishery ranged averaged about 163,000 between 1952 and 1991 (PFMC 2003). Between 1962 and 1993, recreational harvest in California averaged about 34,000 fish. In both cases, these totals represent fish a mixture of fish both naturally produced and hatchery fish originating from Oregon and California. Neither escapement estimates nor estimates of the contribution of SONCC fish to total harvest, from which exploitation rates could be derived, are available. However, there is no doubt that ocean exploitation rates have dropped substantially in response to the non-retention regulations put in place in 1994 as well as general reductions in chinook-directed effort.

Directed river harvest of coho salmon has not been allowed within the SONCC ESU since 1994, with the exception of sanctioned tribal harvest for subsistence, ceremonial, and commercial purposes by the Yurok, Hoopa Valley, and Karuk tribes (CDFG 2002). Harvest data are only available for the Yurok Tribe (2002), which reports that annual harvest of coho salmon from reservation lands on the lower Klamath River has averaged 244 fish (67% marked hatchery fish) between 1997 and 2001, though this average is strongly influenced by a harvest of almost 900 fish in 2001. In the other four years, harvest did not exceed 135 fish. Mortality associated with incidental or illegal catch of naturally produced coho salmon in SONCC rivers is uncertain, but believed to be low (CDFG 2002).



### **C.2.2.5 Comparison with Previous Data**

New data for the SONCC coho salmon ESU includes expansion of presence-absence analyses, a limited analysis of juvenile abundance in the Eel River basin, a few indices of spawner abundance in the Smith, Mad, and Eel river basins, and substantially expanded monitoring of adults, juveniles, and habitat in southern Oregon. None of these data contradict conclusions reached previously by the BRT. Nor do any of recent data (1995 to present) suggest any marked change, either positive or negative, in the abundance or distribution of coho salmon within the SONCC ESU. Coho salmon populations continued to be depressed relative to historical numbers, and there are strong indications that breeding groups have been lost from a significant percentage of streams within their historical range. Although the 2001 broodyear appears to be the one of the strongest perhaps of the last decade, it follows a number of relatively weak years. The Rogue River stock is an exception; there has been an average increase in spawners over the last several years, despite 2 low years (1998, 1999).

Risk factors identified in previous status reviews, including severe declines from historical run sizes, the apparent frequency of local extinctions, long-term trends that are clearly downward, and degraded freshwater habitat and associated reduction in carrying capacity continue to be of concern to the BRT. Termination of hatchery production of coho salmon at the Mad River and Rowdy Creek facilities has eliminated potential adverse risk associated with hatchery releases from these facilities. Likewise, restrictions on recreational and commercial harvest of coho salmon since 1994 have undoubtedly had a substantial positive impact on coho salmon adult returns to SONCC streams. An additional risk factor that has been identified within the SONCC ESU is predation resulting from the illegal introduction of non-native Sacramento pikeminnow (*Ptychocheilus grandis*) to the Eel River basin (NMFS 1998). Sacramento pikeminnow were introduced to the Eel River via Pillsbury Lake in the early 1980s and have subsequently spread to most areas within the basin. The rapid expansion of pikeminnow populations is believed to have been facilitated by alterations in habitat conditions (particularly increased water temperatures) that favor pikeminnow (Brown et al. 1994; NMFS 1998).

## C.3 COHO SALMON BRT CONCLUSIONS

### Oregon Coast coho salmon ESU

This ESU continues to present challenges to those assessing extinction risk. The BRT found several positive features compared to the previous assessment in 1997. Adult spawners for the ESU in 2001 and 2002 exceeded the number observed for any year in the past several decades, and pre-harvest run size rivaled some of the high values seen in the 1970s. Some notable increases in spawners have occurred in many streams in the northern part of the ESU, which was the most depressed area at the time of the last status review evaluation. Hatchery reforms have continued, and the fraction of natural spawners that are first-generation hatchery fish has been reduced in many areas compared to highs in the early to mid 1990s.

On the other hand, the recent years of good returns were preceded by three years of low spawner escapements—the result of three consecutive years of recruitment failure, in which the natural spawners did not replace themselves the next generation, even in the absence of any directed harvest. These three years of recruitment failure, which immediately followed the last status review in 1997, are the only such instances that have been observed in the entire time series of data collected for Oregon Coast coho salmon. Whereas the recent increases in spawner escapement have resulted in long-term trends in spawners that are generally positive, the long-term trends in productivity in this ESU are still strongly negative.

The BRT votes reflected ongoing concerns for the long-term health of this ESU: a majority (56%) of the FEMAT votes were cast in the “likely to become endangered” category, with a substantial minority (44%) falling in the “not likely to become endangered” category (Table C.3.1). Although the BRT considered the significantly higher returns in recent years to be encouraging, most members felt that the factors responsible for the increases were more likely to be unusually favorable marine productivity conditions than improvements in freshwater productivity. The majority of BRT members felt that to have a high degree of confidence that the ESU is healthy, high spawner escapements should be maintained for a number of years, and the freshwater habitat should demonstrate the capability of supporting high juvenile production from years of high spawner abundance. As indicated in the risk matrix results, the BRT considered the decline in productivity to be the most serious concern for this ESU (mean score 3.2; Table C.3.2). With all directed harvest for these populations already eliminated, harvest management can no longer compensate for declining productivity by reducing harvest rates. The BRT was concerned that if the long-term decline in productivity reflects deteriorating conditions in freshwater habitat, this ESU could face very serious risks of local extinctions during the next cycle of poor ocean conditions. With the cushion provided by strong returns in the last 2-3 years, the BRT had much less concern about short-term risks associated with abundance (mean score 1.9).

A minority of the BRT felt that the large number of spawners in the last few years demonstrate that this ESU is not currently at significant risk of extinction or likely to become endangered. Furthermore, these members felt that the recent years of high escapement, following closely on the heels of the years of recruitment failure, demonstrate that populations in this ESU have the resilience to bounce back from years of depressed runs.

## **Southern Oregon/Northern California Coasts coho salmon ESU**

A majority (67%) of BRT votes fell into the “likely to become endangered” category, while votes in the “endangered” category outnumbered those in the “not warranted” categories by 2-to-1 (Table C.3.1). The BRT found moderately high risks for abundance and growth rate/production, with mean matrix scores of 3.5 to 3.8, respectively, for these two categories. Risks to spatial structure (mean score = 3.1) and diversity (mean score = 2.8) were considered moderate by the BRT (Table C.3.2).

The BRT remained concerned about low population abundance throughout the ESU relative to historical numbers and long-term downward trends in abundance; however, the paucity of data on escapement of naturally produced spawners in most basins continued to hinder assessment of risk. A reliable time series of adult abundance is available only for the Rogue River. These data indicate that long-term (22-year) and short-term (10-year) trends in mean spawner abundance are upward in the Rogue; however, the positive trends reflect effects of reduced harvest (rather than improved freshwater conditions) since trends in pre-harvest recruits are flat. Less-reliable indices of spawner abundance in several California populations reveal no apparent trends in some populations and suggest possible continued declines in others. Additionally, the BRT considered the relatively low occupancy rates of historical coho salmon streams (between 37% and 61% from broodyear 1986 to 2000) as an indication of continued low abundance in the California portion of this ESU. The relatively strong 2001 broodyear, likely the result of favorable conditions in both freshwater and marine environments, was viewed as a positive sign, but was a single strong year following more than a decade of generally poor years.

The moderate risk matrix scores for spatial structure reflected a balancing of several factors. On the negative side was the modest percentage of historical streams still occupied by coho salmon (suggestive of local extirpations or depressed populations). The BRT also remains concerned about the possibility that losses of local populations have been masked in basins with high hatchery output, including the Trinity, Klamath, and Rogue systems. The extent to which strays from hatcheries in these systems are contributing to natural production remains uncertain; however, it is generally believed that hatchery fish and progeny of hatchery fish constitute the majority of production in the Trinity River, and may be a significant concern in parts of the Klamath and Rogue systems as well. On the positive side, extant populations can still be found in all major river basins within the ESU. Additionally, the relatively high occupancy rate of historical streams observed in broodyear 2001 suggests that much habitat remains accessible to coho salmon. The BRT’s concern for the large number of hatchery fish in the Rogue, Klamath, and Trinity systems was also evident in the moderate risk rating for diversity.

## **Central California coho salmon ESU**

A large majority (74%) of the BRT votes fell into the “endangered” category, with the remainder falling into the “likely to become endangered” category (Table C.3.1). The BRT found CCC coho salmon to be at very high risk in three of four risk categories, with mean scores of 4.8, 4.5, and 4.7 for abundance, growth rate/productivity, and spatial structure, respectively (Table C.3.2). Scores for diversity (mean 3.6) indicated BRT members considered CCC coho

salmon to be at moderate or increasing risk with respect to this risk category. Principal concerns of the BRT continue to be low abundance and long-term downward trends in abundance of coho salmon throughout the ESU, as well as extirpation or near extirpation of populations across most of the southern two-thirds of the historical range of the ESU, including several major river basins. Potential loss of genetic diversity associated with range reductions or loss of one or more brood lineages, coupled with historical influence of hatchery fish, were primary risks to diversity identified by the BRT. Improved oceanic conditions coupled with favorable stream flows apparently contributed to a strong year class in broodyear 2001, as evidenced by an increase in detected occupancy of historical streams. However, data were lacking for many river basins in the southern two-thirds of the ESU where populations are considered at greatest risk. Although viewed as a positive sign, the strong year follows more than a decade of relatively poor returns. The lack of current estimates of naturally produced spawners for any populations within the ESU—and hence the need to use primarily presence-absence information to assess risk—continues to concern the BRT.

### **Lower Columbia River coho salmon ESU**

The status of this ESU was reviewed by the BRT in 2000, so relatively little new information was available. A majority (68%) of the likelihood votes for Lower Columbia River coho salmon fell in the “danger of extinction” category, with the remainder falling in the “likely to become endangered” category (Table C.3.1). As indicated by the risk matrix totals (Table C.3.2), the BRT had major concerns for this ESU in all VSP risk categories (mean scores ranged from 4.2 for spatial structure/connectivity and growth rate/productivity to 4.5 for diversity). The most serious overall concern was the scarcity of naturally produced spawners throughout the ESU, with attendant risks associated with small population, loss of diversity, and fragmentation and isolation of the remaining naturally produced fish. In the only two populations with significant natural production (Sandy and Clackamas), short and long-term trends are negative and productivity (as gauged by preharvest recruits) is down sharply from recent (1980s) levels. On the positive side, adult returns in 2000 and 2001 were up noticeably in some areas, and evidence for limited natural production has been found in some areas outside the Sandy and Clackamas.

The paucity of naturally produced spawners in this ESU can be contrasted with the very large number of hatchery-produced adults. Although the scale of the hatchery programs, and the great disparity in relative numbers of hatchery and wild fish, produce many genetic and ecological threats to the natural populations, collectively these hatchery populations contain a great deal of genetic resources that might be tapped to help promote restoration of more widespread naturally spawning populations.

Table C.3.1. Tally of FEMAT vote distribution regarding the status of 4 coho salmon ESUs reviewed by the coho salmon BRT. Each of 13 BRT members allocated 10 points among the three status categories.

ESU	Danger of Extinction	Likely to Become Endangered	Not Likely to Become Endangered
Oregon Coast	0	73	57
S. Oregon / N. California Coasts	29	87	14
Central California	96	34	0
Lower Columbia River	88	42	0

Table C.3.2. Summary of risk scores (1 = low to 5 = high) for four VSP categories (see section "Factors Considered in Status Assessments" for a description of the risk categories) for the 4 coho salmon ESUs reviewed. Data presented are means (range).

ESU	Abundance	Growth Rate/Productivity	Spatial Structure and Connectivity	Diversity
Oregon Coast	1.9 (1-3)	3.2 (2-4)	2.3 (1-3)	2.5 (2-3)
S. Oregon / N. California Coasts	3.8 (2-5)	3.5 (2-5)	3.1 (2-4)	2.8 (2-4)
Central California	4.8 (4-5)	4.5 (4-5)	4.7 (4-5)	3.6 (2-5)
Lower Columbia River	4.4 (4-5)	4.2 (3-5)	4.2 (2-5)	4.5 (4-5)

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